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94 FEBRUARY 1, 1941 No. 3

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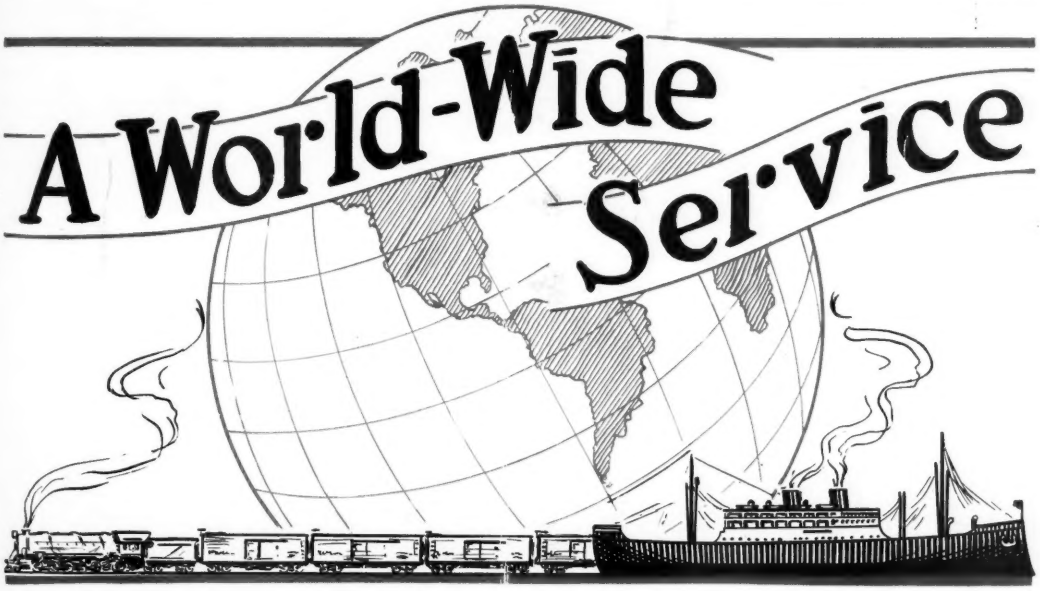

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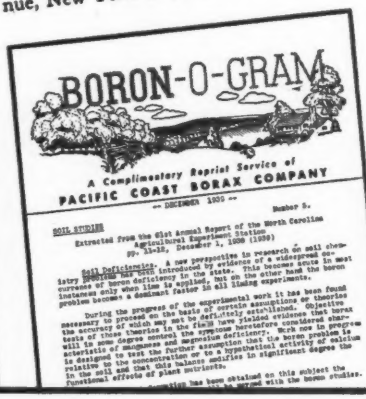
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Vol. 94 FEBRUARY 1, 1941 No. 3

Fertilizer Pellets and Cubes

By S. D. WILKINS*

FIXATION of phosphate and potash in certain type soils; loss of applied nitrogen through leaching and volatilization in other soils; the danger of fertilizer "burn" from applications too close to the seed and roots, whether used for field crops, greenhouse operations or potted and boxed plants; difficulties of deep placement in fruit and shade tree fertilization with finely pulverized fertilizers; the disagreeable odor and dustiness of dried pulverized manures and composts together with loss of nitrogen and vitamin B-1 from piles of these two materials; the added cost of side dressings for row crops; all these and other conditions have been responsible for interest in and studies of the problems of fertilizer granulation, by pelleting, cubing and kibbling.

Some fertilizer materials are as easily and as inexpensively pelleted as are feedstuffs; others present problems which must be solved for the specific product before it can be compressed at a cost under that of any enhanced value the new form has, whether that be agronomic value or better physical characteristics.

The following materials have been pelleted or cubed in sizes ranging from $^3/_{32}$ inch diameter to 1¼ inch, cut to lengths varying from that of the thinness of a thin razor blade to several inches long. The list includes ammonium sulphate, ammonium phosphate, nitrate of soda, calcium nitrate, ammonium nitrate, urea, organic ammoniates alone and in mixtures, tankage, fish meals, sewage sludge, leather scraps, superphosphate and treble superphosphate, muriate and sulphate of potash, poultry, sheep and cattle manures, peat alone and in various combinations and composts made from a variety of mixed fertilizers, manures and waste products. The accompanying Fig. 1 shows but a few of the different sizes and types of fertilizer pellets which have been made.

Inorganic and organic fertilizers and mixtures in a variety of formulas have been applied as pellets or cubes in fertilizer studies with a number of crops and in different ways. Pellets of ammonium sulphate $^3/_{32}$ inch and ⅛ inch in diameter have been used in fertilizing flooded rice fields by airplane application. The pellets are heavy enough to sink rapidly and this is an important factor as was found in a study of pellets made of ammonium sulphate and an organic ammoniate. These latter pellets were of so light weight that, when broadcast on water roughened by the wind, they floated to the edge of the flooded area and uneven fertilization resulted. These same light pellets have proved valuable as a lawn fertilizer when broadcast by hand or with a fan type seed distributor.

Pellets of superphosphate, $^3/_{16}$ inch in diameter and cut to the same length, have been drilled into the soil together with barley seed and have been broadcast applied on the surface and then carried deeper into the soil through subsequent tillage operations in making the seed beds for sugar beets and other row crops. Larger pellets and cubes of sulphate and muriate of potash have been used in fertilizer tests with prune, apricot and other deciduous trees. In some cases the pellets were dropped in furrows at varying distances from the trunk of the trees and some has been dropped into holes spaced uniformly about the trees.

In stick form, that is, material extruded from the pellet mill die and cut into lengths from one inch to four or five inches or longer, organic fertilizers have been used with excellent results in pot cultures and in the growing of potted house plants. To a limited extent, in-

* Consulting Biochemist, Berkeley, California.

organics in the same form have been made and are being tested.

In the case of some fertilizer salts, impurities in the product appear to be a factor responsible for the production of smooth, uniform, hard, stabilized pellets or cubes which are non-hygroscopic and which do not shatter in handling. Of course, fertilizers of high purity are being pelleted and cubed and they are stable in every way. Calcium and sodium nitrate pellets of very small size, packaged in various types of containers and even left in the open, exposed to atmospheric conditions, sometimes of high humidity, for more than two years have retained their uniform pellet shape and remained dry. No stabilizer was used in their preparation.

two per cent of the tempering water will be removed because of frictional and heat loss as the fertilizer is forced through the die. With most fertilizer materials, once the cooling system is loaded to capacity, usually one to one and one-half tons, pellets or cubes can be sacked off as rapidly as they are being made. If the pellets or cubes are to be piled, for bulk shipment, they can be carried directly from the pellet mill die or from the cooler on suitably arranged belt carriers.

The importance of proper tempering of a fertilizer on the color of pellets was shown in the case of a fertilizer salt compressed without additions of water or use of steam. The fertilizer was a very white product but when extruded without tempering, the pellets and cubes

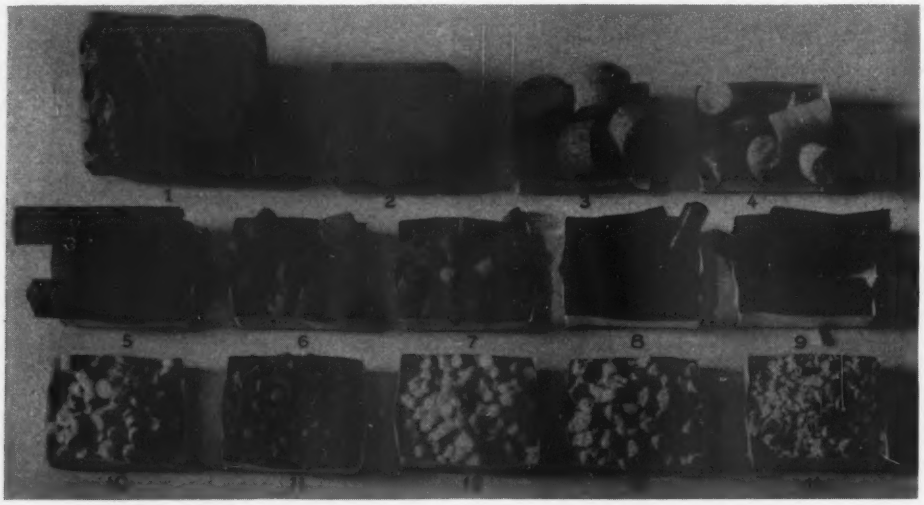

FIG. 1. Samples of fertilizers formed into cubes, rods and pellets. 1. Ammonium sulphate, 1 in. cube; 2. Muriate of potash, ⅞ in. cubs; 3. Ammonium sulphate, ½ in. pellets; 4. Sulphate of potash, 3/16 in. pellets; 5. Poultry manure, ¼ in. sticks; 6. Poultry manure and ammonium sulphate, 3/16 in. pellets; 7. Superphosphate 18%, 3/16 in. pellets; 8. Sewage sludge, 3/16 in. sticks; 9. Sheep manure, 5/32 in. sticks; 10. Ammonium sulphate, 1/8 in. pellets; 11. Ammonium sulphate and cottonseed meal, 3/32 in. pellets; 12. Nitrate of soda, 3/32 in. pellets; 13 and 14. Sulphate of potash, kibbled.

The degree of hardness, the color and the rate of solubility of any given fertilizer pellet or cube produced on a given die will vary, depending upon whether steam or water or other lubricant be used; whether the granulation of the material as it goes to the die is fairly uniform or not, whether it is fed to the die at varying rate of speed, the thickness of the die and shape of die holes and the condition of the die. Some fertilizers, when pelleted, will require subsequent cooling and drying, the amount of which depends upon the initial moisture content of the mix and the amount of water added as steam or otherwise. Roughly

were gray to black and according to the manufacturer would be unsalable. More of the white material was tempered with four per cent of water and pellets and cubes of excellent color and bonding were readily produced. Some of these pellets were sacked immediately in both paper and cloth bags and at present, one year later, they are in perfect condition.

If prejudices against changes of color of certain inorganic fertilizers could be eliminated, the cost of pelleting these could be reduced for additions of small amounts of organic ammoniates or of lubricants, such as fine mesh graphite, mineral oil or cheap fats, permit in-

creasing weights of the material to be forced through the die in unit time. Incidentally this also protects the die against abrasive wear.

Rust, following the pelleting of inorganics is perhaps the most important cause of die wear and of pitted and rust colored pellets or cubes. Rust can be avoided if the operator will force through the die holes on completion of a run a generous amount of corn meal or of bran mixed with cheap oil. This is especially important when the machine is stopped for several hours for it permits quicker pellet formation when operations are resumed. When the machine is not used for a day or more, it is good practice to remove the die and keep it in an oil bath.

Pelleting Prevents Losses of Important Plant Growth Factors

In connection with studies of the fertilization of potted flowers by means of manures compressed into sticks, two to three inches long, the writer has had a number of assays made of the vitamin B-1 content of pulverized manures and of the sticks made from these manures. These included sheep manure, poultry manure free of litter, cattle manures and mixtures of these as well as of composts in which manures were utilized to a large extent. The assays show that the compressed manures are high in Vitamin B-1 and the initial assays of the manures in pulverized form were likewise high. But, whereas the pellets and sticks of these same manures, when assayed at the end of eight months and one year, contained almost the same amount of Vitamin B-1 as they did within a week or ten days after pelleting, the pulverized manures and composts which had been kept in piles of several tons each for a like period had lost one-half or more of their nitrogen and in some instances eighty per cent of the vitamin factor.

A study is being continued of the effect of pelleting manures collected in different manner and of the effect of different litters on the fertilizing value of such pelleted manures as well as on the actual pelleting process. Poultry manure collected on floors littered with coffee bran has been run through the pellet mill die without intervening drying or grinding. The moisture content of the manure-coffee bran mixture when pelleted was eighteen per cent and over a period of nearly nine months the pellets packed in burlap bags have kept perfectly. Eighteen per cent moisture pellets, of many materials, are not apt to keep well.

There may be value to the practice of pelleting or cubing manures plus superphosphate wholly apart from the greater ease of making stable pellets of this or some other combination. It has been shown by a number of research workers that, when fertilizer is placed in holes about fruit trees, the expected concentration of roots about the fertilizer did not always follow, presumably because the concentration of fertilizer was too high for a great deal of penetration. Perhaps a solution is the use of a large size cube of a fertilizer of lower plant food content.

Losses of nitrogen by leaching and volatilization is high in certain citrus orchard fertilizer practice. It is reported that citrus growers are in some instances adding three or four times as much nitrogen fertilizer as can be accounted for by analysis of the fruit yields and tree growth and it is suggested that losses by leaching and volatilization can be avoided or lessened by frequent applications of smaller amounts of the fertilizer. The labor cost of frequent applications must be considered.

It would be interesting to compare applications of fertilizer in pellets and cubes and of the usual granulation, of the same nitrogen fertilizers.

Fertilizers and disease control or inhibiting chemicals in pellets and horticultural plants in holes made with the crow-bar, soil auger, spade or furrow. Tests are being made of a pelleted peat around the roots of newly transplanted trees and a number of special items in pellets have been made for greenhouse and field crop practice and tests.

What Does It Cost to Pellet or Cube Fertilizers?

Cost data furnished the writer with respect to certain fertilizer pelleting operations show that dried sludges, dried poultry and sheep manures, composts, organic ammoniates and similar materials were pelleted in a $\frac{3}{16}$ inch diameter size at a cost of fifty cents or less per ton of pellets. This cost included labor, die wear and replacement, interest and power consumption and is based upon continuous mill operation. Since pellet and cube mills are of different sizes and production capacity, the cost per ton of pellets extruded will vary somewhat. Pellets of calcium nitrate and sodium nitrate ($^3/_{32}$ inch diameter) are reported produced at a cost ranging from eighty cents to one dollar per ton. $^3/_{32}$ inch pellets of a mixture of ammonium sulphate and cottonseed meal cost from fifty to fifty-five cents per ton while cost data

(Continued on page 22)

NEW BOOKLET ON PLANT HUNGER ISSUED BY CHILEAN NITRATE BUREAU

"If They Could Speak," a 56-page booklet containing ninety-five, four-color illustrations of plant food deficiency diseases in field plants is just off the press. The color plates were made from kodachrome transparencies and the range of subjects includes boron, calcium, copper, iron, magnesium, manganese, nitrogen. potash and zinc deficiencies in alfalfa, apples, beets, blueberries, cabbage, carrots, cauliflower, celery, citrus, corn, cotton, cucumber, dogwood, grapes, endive, romaine lettuce, milkweed, oats, peanuts, peaches, peppers, potatoes, raspberries, roses, rutabagas, snap beans, soybeans, squash, sweet potatoes, swiss chard, tobacco, tomatoes, velvet beans and wheat.

Preparation of the material required about 18 months and involved the development of a practical technique in the direct reproduction of four-color plates from kodachrome transparencies. As a result, color values have been faithfully reproduced and the illustrations in the booklet comprise a remarkably accurate portrayal of the deficiency symptoms as observed in the field. Each plate is accompanied by a descriptive identification.

Those desiring copies of this booklet may obtain them by writing to Chilean Nitrate Educational Bureau, Inc., 120 Broadway, New York, N. Y.

PHOSPHATE RESERVES SHOW LARGE GAIN

Phosphate reserves in the United States have been estimated at more than 10,000,000,000 tons, excluding those reserves classed as potential or the phosphatic limestones of Florida and Tennessee, according to Dr. George R. Mansfield, of the United States Geological Survey, whose study of phosphate resources has been incorporated in the report of the joint congressional committee appointed to estimate the adequacy and use of phosphate.

Representative Peterson, of Florida, committee chairman, in releasing his report, stated that data have been gathered from various bureaus and agencies of the government, because the continuous session of Congress has prevented the committee from holding hearings in the field. Funds authorized for the investigation, he said, have therefore been held intact.

The current annual rate of consumption in the United States is $3,000,000 tons, Dr. Mansfield reported, and therefore the 10,000,000,000 tons would indicate that no need exists for the curtailment of exports. Dr. Mansfield pointed out that more than 66,000 acres of withdrawn land in the Florida field and nearly 2,000,000 acres of withdrawn land in the Western phosphate field remain to be examined, he added that figures for reserves may still be enlarged further.

SALES DATA SUBPOENAED BY GRAND JURY

The Grand Jury fertilizer investigation which has been continuing at Winston-Salem, N. C., for several months, is now reported to have subpoenaed the sales managers of a number of companies. They will be required to produce copies of their 1939, 1940, and 1941 price schedules; copies of any such schedules received from competitors; list of all competitors to whom copies of their schedules were sent; all correspondence relating to the sending of their schedules to competitors; and all correspondence relating to obtaining copies of competitors' schedules. Subpoenas have been issued for companies in New England, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, Florida, Arkansas, Louisiana, Ohio, Indiana, Michigan, and Kentucky.

COTTONSEED MEAL FIGURES

The output of cottonseed meal and cake during the last five months of 1940, totaled 1,030,026 tons, compared with 1,137,074 tons during the same period (August 31st to December 31st) of 1939. Shipments during the same relative periods were 933,827 tons in 1940 and 1,037,380 tons in 1939. Stocks on hand December 31, 1940, amounted to 175,700 tons compared with 219,412 tons at the close of 1939.

SUGAR COMPANY MAKES LARGE FERTILIZER PURCHASES

An expenditure of $150,000 during 1940 for fertilizers is reported by the United States Sugar Corporation of Clewiston, Fla. The company operates ten large plantations in the Florida Everglades. According to President Clarence R. Bitting, about $112,000 was spent for muriate of potash and about $38,000 for fertilizer mixtures. Even larger purchases might have been made but for the restricted production made necessary by the federal allotment plan.

Recent Experience With Phosphate Fertilizer*

By OLLE FRANCK**

THE original phosphate-bearing commercial fertilizer was bone meal. This phosphorus compound is practically insoluble in water. When, therefore, such a fertilizer is spread on the field, the phosphorus cannot be washed down and distributed by the rainfall through the soil layer in which occurs the main part of the plant root which takes in the nutritive salts. In any event, it does not get down to the root layer soon enough. In the case of agricultural crops the root layer which takes in the nutritive salts is usually two to eight inches below the surface of the soil. The grasses and other crops which are regularly cultivated have a root layer of considerable size. It is therefore necessary, when a water-insoluble fertilizer is employed, to work it in with the cultivator or plow.

In 1840 Liebig proposed treating bone meal and raw phosphate with sulphuric acid for the purpose of obtaining a water-soluble phosphate. Through the employment of a fertilizer containing water-soluble phosphoric acid, it was thought that phosphorus, in a form which could easily be taken in by the crop, could be distributed by means of the ground water in the soil layer in which the roots are present. Through this expedient the nutriment was supposed to be made easily available to the crop both physiologically and locally.

As early as 1850 it had already been found that phosphorus combines in the soil into many difficult soluble compounds, so that it is necessary considerably to diminish its reactivity with ground water. The fact that the transformations of water-soluble phosphates, such as occur in the soil, are as temporary as we now know them to be does not, however, seem to have become fully clear at that time. In any event, what was questioned at the time was the practical behavior of the fertilizer, and not the full consequences thereof. With regard to the distribution of the phosphate in the soil in a suitable manner, it became the practice to depend on the water-solubility of the phosphoric acid in superphosphate, and to ignore more and more the working of the phosphate fertilizer down into the root layer. Dannfelt, however, was still teaching in his agricultural writings as late as 1915 that, in order to render superphosphate readily soluble in the soil, it must be well spread out and worked in with the plow or cultivator. Dannfelt, moreover, advised against using superphosphate as a top dressing "because most of it is likely to remain on the surface and not get down to the growing roots." In Feilitz's "Directions for Carrying on Local Fertilizing Experiments" in 1922 we are reminded that "the working of the soil for spring planting must be so thorough that no further very deep working will be required after fertilizing." This means that the fertilizer should be worked in by means of a light harrowing

A light harrowing, however, incorporates the fertilizer only down to a depth of one-half to one or two inches, and hence does not get into the real root zone. Torstensson has found that in working the soil with a deeply penetrating cultivator for any number of times it is not possible to work the fertilizer into the soil to a depth of more than two or three inches. A large part of the fertilizer, therefore, remains in the topmost layer even after a deep harrowing, where there is practically no root growth and which is, furthermore, bone dry during a large part of the growing season, unless the fertilizer has been washed down into the soil by rain.

Conflicting Results

At the Central Experimental Field of the Department of Agriculture (Sweden) extensive researches and experiments relating to phosphate problems have been conducted during the past ten years. One of the reasons which determined the Department of Agriculture to devote special attention to phosphate problems was the mutually contradictory and inconsequential results which have so often been obtained not only in repeated fertilizing experiments in the field, but also in comparing the findings of the field experiments with cer-

* Presented at the Annual Convention of the Royal Swedish Chamber of Agriculture, January 28, 1939. From Kungl. Lantbruksakademiens Tidskrift, No. 2, pp. 113-124 (1939).

** Central Station for Agricultural Research, Stockholm, Sweden.

tain biological and chemical processes in agriculture, which the Department desired to study.

Thus, in carrying out field experiments in acid loam in accordance with the conventional methods—that is, employing, as a different fertilizer, a comparatively small amount of superphosphate which was not harrowed in very far—it was usually found that the phosphate fertilizer had no effect, despite the fact that the content of plant-soluble phosphoric acid in the soil was so low according to chemical analysis that there seemed every likelihood that an increase in the phosphate factor would bring about a considerable improvement in the final crop. In box experiments carried out according to Mitscherlich's method, we also obtained excellent results with phosphate fertilizers. No phosphorus could have been taken from the subsoil since this was even poorer in phosphate than the humus. In the box experiments, tests were arranged also so that the phosphoric acid would be available both locally —through intermixture in all of the soil in which the roots grow—and physiologically—through very large amounts of phosphate, that is, in the proportion of 10,900 pounds to 16,350 pounds of superphosphate per acre, and plenty of water. Whether or not the phosphate factor is satisfactory can certainly be determined by box experiments. And in this instance the box experiments do show that the phosphate condition of the soil is unsatisfactory. Hence, the box experiments and the chemical analysis of the soil are in agreement but not the field experiments. The first problem to be solved, therefore, is why plants in the field experiments are not able to use up the available phosphoric acid.

Behavior of Phosphates in the Soil

Following is a description of some of the work carried out by the Department of Agriculture (Sweden) for the purpose of clearing up this problem, together with the results obtained.

In order to determine how the soluble phosphoric acid in superphosphate behaves in the soil, the following series of experiments was arranged: Six different types of soil were studied. Portions of two pounds of each type of soil were weighed out, and mixed with increasing amounts of superphosphate. The soil was then put in a glass cylinder and saturated with water poured in from the top. After the cylinder has been dried in the air, the phosphoric acid is both water- and lactate-soluble. It has been found that the behavior of this lactate-soluble phosphoric acid gives a good idea of the behavior of plant-soluble phosphoric acid.

According to these tests, phosphoric acid is retained in the water-soluble form in any large amounts, that is 15 to 20 per cent, only in lime-rich (pH 7.4), sandy ground. In neutral loam, only 7 to 9 per cent remains in the water-soluble form. Still less remains in acid soil, and least of all in very acid clay, in which only about 1 per cent remains in the water-soluble form. In the lactate-soluble form, 63 per cent remains in the lime-rich sand, in the loam 27 to 43 per cent, in the acid soil about 30 per cent, and in the very acid clay only about 16 per cent.

It should also be noted that the larger the amounts of phosphate employed, the larger proportionately the amounts remaining in the soluble form. This is particularly true of the nearly neutral loam. The soil seems to be very close to the saturation point of phosphate. The prepared lime-rich sands reach the saturation point with the least addition.

Some research workers on the water-solubility of phosphoric acid when applied on fields have found that practically all the phosphoric acid in finely pulverized superphosphate can be converted into a difficultly soluble form within a short time after coming in contact with moist soil. After drying, the material is usually firmly retained, and this hold is still further increased if the soil is moistened and dried gradually.

Vertical Application Needed

The difficulty which the phosphate experiences in being transported by the ground water must be compensated by disposing it vertically in the soil. And the very extensive studies on cross sections of soils which the Department of Agriculture has carried on since 1931 show that this does, in fact, usually apply to all the natural soils, excepting sandy soils which are wholly free of loam, and gravelly sand.

Thus the content of readily soluble phosphoric acids in soils which are not regularly worked with the plow was very high in the surface zone (0 to 2 inches), and diminished rapidly with deeper penetration. In regularly cultivated fields the plowed layer was considerably richer in phosphate than the subsoil, and the dividing line between the two soils was clearly noticeable. Due to the fact that the fertilizer is not naturally carried through the soil mass, the first requirement is to spread it in such a way that it is locally available to the plants, that is, in the root zones. In a spring sowing experiment in a soil whose phosphate

condition was unsatisfactory, 880 pounds of superphosphate were applied, a part harrowed in, and the rest plowed in. Plowing gave a yield of about 1,495 pounds more per acre than harrowing in. In another extensive experimental series, deeper and more thorough harrowing in of the superphosphate on soils which are extremely poor in phosphate gave average increases of about 544 pounds per acre.

It therefore follows that some kind of mechanical work is required in order to distribute the phosphorus in the soil. The growth process itself, however, serves to "pump" phosphorus from the deep layers of the soil to the surface layer. That is, the plant itself absorbs phosphorus through its roots and transports it to its part above the ground. Leaves fallen from trees and shrubs, dead vegetative parts of plants, the excreta of animals grazing in meadows and hayfields, return phosphorus to the surface, whence it is carried back into the deeper layers much more slowly than it was carried up. Thus the surface is kept very rich in phosphate. This can be seen in cross sections of soils. For example, a cross section from an orchard meadow in the middle of Sweden showed the following: 0 to 2 inches below the surface, more than 20 units of lactate; 2 to 4 inches below the surface, about 6 units of lactate; 4 to 6 inches below the surface, about 2 units of lactate; 6 to 8 inches below the surface, about 1 unit of lactate; 8 to 16 inches below the surface, about 0.5 unit of lactate.

Distribution by Ground Water

When a field which used to be cultivated is turned into a pasture, the difference in the phosphate content between the plowed layer and the subsoil disappears. That is, the phosphate diminishes at the bottom of the plowed layer (through phosphate being taken in by the roots) and increases right on the surface (through the animal excreta).

It is out of the ground water that the plant takes in through its roots its phosphorus-bearing nutritive salts. The phosphate content in the ground water of any soil is very low, regardless of the degree of fertility. That is, a quart of ground water usually contains less than twenty-two millionths of a pound of phosphorus. This means that in an acre of humus layer there is no more phosphorus than in 11 to 22 pounds of 20% superphosphate. For example, it can be said that, depending on the kind, size and condition of the crop, the amount of phosphorus used up per year per acre corresponds to 815 to 2,710 pounds of 20% super phosphate. The low content of phosphate in the ground water does not, however, have much bearing on the problem under consideration, because any crop can easily take in phosphates from such dilute solutions as are here concerned. From the standpoint of plant nourishment, however, it is of the greatest importance that the phosphates in the ground water should be replaced as fast as they are used up by the plants. Certain solid particles of earth, which are to be regarded as fertilizer fragments, are suppliers of phosphate. If the phosphate is supplied to the ground water at an insufficient speed and in insufficient amounts, the plants suffer from phosphorus hunger, and the harvested crop is deficient both in amount and in quality. In other words, the phosphate condition of the field is unsatisfactory. The unsatisfactory phosphate condition may be due either to an excessively slow speed of supply, or to the fact that the phosphate reserves are running low, or to both of these causes.

Effect of Other Elements

Some of the metals, particularly aluminum and iron, are able, since they are present in the ground water in the ionized form, to exert an adverse influence on plant growth. This damage may be due either to a direct poisoning effect or to a lessened availability of the phosphate caused by its combining with a metal to form an insoluble compound. Thus aluminum seems to be a specific root poison which prevents the root tissues from functioning normally. This metal is able to precipitate phosphate not only out of the ground water but even out of the very root tissues. This is why plants in very acid soils frequently show a deficiency in phosphate which manifests itself in broken leaves, or a strong reddish-violet coloring at the base of the stems, etc.

Various types of plants react very differently to an excess of aluminum or iron. Thus the bifarious grains (rye, wheat, etc.) are much more sensitive than oats. Oats can more readily assimilate phosphoric acid at lower pH values, that is when aluminum and iron are present in the ionized form.

The transformation of the metals just mentioned into the ionized form occurs, however, at different degrees of acidity (pH value) depending on the fundamental chemical composition of the soil. According to Mattson's researches, as published in a series of articles in *Soil Science,* and according to the Annual Reports of the University of Agriculture, the colloidal content of the soil is determined by

(Continued on page 26)

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Research the Best Safeguard Against Post-War Depression

Research, always important to industry, is imperative today if America is to prevent the recurrence of economic dislocation such as that which followed 1917-18, according to Dr. Karl T. Compton, president of the Massachusetts Institute of Technology and chairman of the National Association of Manufacturers' Advisory Committee on Research.

"The prosperity the production of armaments seems to produce is only a pseudo-prosperity," said Dr. Compton in a report published by the N.A.M. Committee on Patents and Research.

"Guns and planes and tanks, although essential now to national safety, are not wealth-creating machines.

"National defense orders are only a stimulant injected into industry's bloodstream, and the effects of the stimulant will wear off. We must prepare now for the time when the government ceases to order large quantities of armaments. We must originate now the products and processes which will keep our assembly lines busy after this emergency."

Dr. Compton recommended that all manufacturing companies invest 2 per cent of their gross sales in research, the average found to prevail in 181 companies studied by N.A.M.

"No company is too small to conduct research." said Dr. Compton.

"It is not necessary to build a costly laboratory and equip it with expensive scientific instruments to obtain the benefits of industrial research. Research projects today can be cut to fit any man's or any company's budget.

"Private laboratories and engineering consultant services are to be found throughout the country. The services are available for research assignments of almost any type and almost any size.

"Many small companies, not now able to support research laboratories, can move in the desired direction by hiring a competent young engineer or scientist and giving him a relatively free hand to study the processes, products and technical problems of the company looking to eventual suggestions for improvement or development.

"Many companies desiring to have specific subjects studied by trained scientists have provided graduate fellowships in universities or research foundations. Many of these fellowships are financed at a figure as low as $750 a year, and such projects can be elaborated to almost any scale by special arrangements.

"Research foundations, usually endowed, but dependent largely upon fees from industry, are conducting an increasing amount of industrial research. Many of the outstanding industrial developments of recent years have come from these research foundations.

"In a survey just completed, it was found that 35 out of 113 manufacturing trade associations affiliated with the National Association of Manufacturers in the National Industrial Council, conduct research activities. Eleven of them have their own laboratories or cooperate with others in supporting laboratories. The average annual research budget of 27 associations reporting specific figures was $36,960. The median budget was $25,000. Two associations spend more than $100,000 a year. Twenty-one of the associations finance research projects for their members at universities, 7 at research foundations and 3 at commercial laboratories.

"Many of the most successful company research programs have grown from small beginnings. A few hundred dollars worth of equipment in a corner of the plant used part time by engineers or other staff members may lead, by sound successive steps, to separate laboratories staffed by full-time research technicians.

"Income appropriated to research is not spent; it is invested. The question is not whether a company can afford to engage in research but whether it can afford not to, particularly when it is realized that after this emergency has passed, orders for the normal consumer market must be found to replace government orders. This market can be created only by new and better products.

"If your company does not have a research program, prepare to launch one now. If it has a research program, expand it."

TENNESSEE FERTILIZER CONFERENCE

The Tennessee Fertilizer Conference, held at Nashville on January 24th, was attended by 55 persons, of whom 40 were connected with the fertilizer industry. An interesting program had been arranged by the University of Tennessee, the Tennessee Department of Agriculture and the National Fertilizer Association.

Director C. A. Mooers of the Tennessee Agricultural Experiment Station, gave a most interesting statement as to the use of fertilizers in Tennessee by geographical areas, showing that the phosphorus-deficient lands of the state were the largest users of fertilizer, and that where the initial supply of phosphorus had met the needs at the outset, increased production of crops soon necessitated the use of complete fertilizers because of exhaustion of the natural supply of the other elements. The Superintendents of the branch stations at Jackson, Tenn., and the Tobacco Station at Greeneville likewise brought out the fact that soil well supplied with phosphate gave best results with other fertilizer elements, and the corollary proposition that good fertilizers for Burley tobacco in other than the Middle Basin Areas where nature had already supplied it, must contain large proportions of phosphate.

For the National Fertilizer Association, Mr. Smalley discussed "Trends in Fertilizer Manufacture and Usage," Mr. Lush led the discussion on "Pasture Fertilization," and Mr. Brand addressed the dinner session on "The War's Effect on American Agriculture."

SULPHATE OF AMMONIA OUTPUT INCREASING

With a December output of 634,382 tons of by-product sulphate of ammonia and 2,655 tons (NH_3 content) of by-product ammonia liquor, according to the U. S. Bureau of Mines, the industry completed a banner year with a tonnage which was surpassed only by the record year of 1929. During 1929, the total output of both sulphate and ammonia liquor, figured in terms of sulphate, was 911,251 tons. If the figures for 1940 were changed to the same basis, the total would be 858,807 tons.

December, 1940, was the best month of the year for both sulphate and liquor, as production exceeded November by 2.4 per cent and 6.4 per cent respectively. For December, 1939 the figures show 60,636 tons of sulphate of ammonia and 2,452 tons (NH_3 content) of ammonia liquor. For the year 1940, sulphate production was 23.2 per cent greater than in 1939, and ammonia liquor 17.4 per cent greater.

The tabulated figures for the year as as follows:

	Sulphate of Ammonia Tons	Ammonia Liquor (NH_3 content) Tons
January	60,393	2,404
February	53,475	2,267
March	56,059	2,252
April	54,569	2,163
May	57,697	2,209
June	58,514	2,190
July	60,718	2,358
August	62,254	2,347
September	62,483	2,412
October	63,805	2,570
November	62,843	2,496
December	64,382	2,655
Total 1940	717,192	28,323
Total 1939	580,274	24,132

Obituary

BENJAMIN H. BREWSTER, JR.

The fertilizer industry has lost one of its most active leaders through the death of Benjamin H. Brewster, Jr., president of the Baugh & Sons Company and the Baugh Chemical Company. Mr. Brewster, who was 68 years of age, died suddenly on January 28th at Boca Grande, Florida, where he had gone to recuperate from an attack of bronchitis.

BENJAMIN H. BREWSTER, JR.

Mr. Brewster was born in Philadelphia and received his education in the local schools and at the University of Pennsylvania, from which he graduated in 1891. Shortly thereafter he joined the Baugh and Sons Company, serving as secretary until 1901, as vice-president from 1901 to 1928, and as president from 1928 until his death. When the Baugh Chemical Company was formed, Mr. Brewster was elected to the office of president.

For more than twenty years Mr. Brewster has given generously of his time and ability to promote the welfare of the industry through its trade organization, the National Fertilizer Association. Elected to the Board of Directors in 1921, he served for several terms, being one of the members from District 3 at the time of his death. He also served on the Executive and Public Relations Committees.

Mr. Brewster was also active in Baltimore financial circles, being chairman of the Union Trust Co. and a director of the Eutaw Savings Bank. He was also a director of the Sheppard and Enoch Pratt Hospital and of the Hospital for Women.

He is survived by his widow, Elizabeth Baugh Brewster; a son, Benjamin H. Brewster, III, 1st vice-president of the Baugh Companies; a daughter, Mrs. Francis White, of New York; and a brother, Major General André W. Brewster, U. S. A. (retired).

WITTENBERG JOINS I. A. C.

On January 1st, Robert B. Wittenberg joined the staff of the International Agricultural Corporation. He will be located at the New York offices and will handle market research and trade sales development work in minerals and chemicals. Mr. Wittenberg is a graduate of Yale University in chemical engineering and for eight years was with the Grasselli Chemical Company. In 1932 he joined the Mathieson Alkali Works, in the research and development department, from which position he resigned on January 1st to go with the International Agricultural Corporation.

BRADLEY & BAKER

FERTILIZER MATERIALS - FEEDSTUFFS

AGENTS - IMPORTERS - BROKERS

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Baltimore, Md.

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Norfolk, Va.

1252 West Beaver Street
Jacksonville, Fla.

FERTILIZER MATERIALS MARKET

NEW YORK

Good Spring Season Expected and Manufacturers Will Need Additional Materials. Supplies of Potash and Sulphate of Ammonia Ample for Domestic Needs. Potash Exports to be Licensed.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, January 31, 1941.

Producers of potash are doing all possible to fill the demand from fertilizer manufacturers for prompt deliveries against contracts, and in like manner the demand from fertilizer manufacturers for sulphate of ammonia is being maintained.

From present indications, fertilizer manufacturers are not over-bought on any of the basic materials, as general belief seems to be that general demand for fertilizers in most parts of the country will be good.

However, due to the increased production of potash in this country and also the increased production of sulphate of ammonia, there should be ample supplies here to fill all demands of domestic consumers.

Nitrate of Soda

$29.40 per ton in 100 lb. bags, $28.70 in 200 lb. bags, and $27.00 in bulk, all f.o.b. port warehouse. Supplies continue to be ample and movement of material is strictly against contract.

Sulphate of Ammonia

There have been several demands for large quantities for export within the last few weeks but at prices at which sellers would be unwilling to supply even if material was available. With the possibility that securing of export licenses will become more difficult, it is fair to assume that the present situation may change.

Superphosphate

Ordinary material is in good demand with no change in price. Triple superphosphate is available to domestic users of this material at schedule although most manufacturers are well sold up.

Potash

Considerable quantities of potash have been exported but with the necessity of export licenses for potash salts for export after Februard 2nd, no estimate can be made at this time on probable quantities which would be sold for shipment out of this country until Washington's attitude on the granting of export licenses is ascertained.

Bone Meal

There is no change in quoted price on South American raw bone meal.

Dried Blood

Had a spurt of activity for a few days when local price at New York was changed to $3.00 ($3.64½ per unit N) but this figure was subsequently reduced. Local material could be bought today at $2.75 ($3.34½ per unit N) f.o.b. New York. South American is not available because of lack of freight.

Tankage

Is quoted at $2.85 (4.46½ per unit N) and 10 but there is general lack of interest.

RUTLAND NOW WITH UNION POTASH

The Union Potash and Chemical Company has announced the appointment of J. W. Rutland as Southern Sales Representative, with offices at 494 Spring St., N. W., Atlanta, Ga. Mr. Rutland has a wide acquaintance in the fertilizer industry, having been connected with the International Agricultural Corporation for many years, as head of the Materials Department.

WISLER JOINS SEA BOARD SUPPLY CO.

J. J. Wisler, who has been associated for the past 17 years with Samuel D. Keim, broker in fertilizer materials, of Philadelphia, has tendered his resignation and is now connected with the Sea Board Supply Co., Meadow and McKean Sts., Philadelphia, where he will center his efforts on feed concentrates. His many friends in the fertilizer industry wish him the fullest success in this new connection.

FERTILIZER MATERIALS

Let Us Quote You
on Your Requirements of These Materials

- PHOSPHATE ROCK
- SUPERPHOSPHATE
- DOUBLE SUPERPHOSPHATE
- NITRATE *of* SODA
- SULPHURIC ACID
- SULPHATE *of* AMMONIA
- BONE MEALS
- POTASH SALTS
- DRIED BLOOD
- TANKAGES
- COTTONSEED MEAL
- BONE BLACK
- PIGMENT BLACK
- SODIUM FLUOSILICATE

Armour's BIG CROP FERTILIZERS

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Division Sales Offices:

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Atlanta, Ga.
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Baltimore, Md.
Birmingham, Ala.
Chicago Heights, Ill.
Cincinnati, Ohio
Columbia, S. C.
Columbus, Ga.
East St. Louis, Ill.
Greensboro, N. C.
Havana, Cuba
Houston, Texas
Jacksonville, Fla.
Montgomery, Ala.
Nashville, Tenn.
New Orleans, La.
New York, N. Y.
Norfolk, Va.
Presque Isle, Me.
San Juan, P. R.
Sandusky, Ohio
Wilmington, N. C.

ATLANTA

Restricted Ocean Shipping Facilities Handicap Fertilizer Imports. Normal Spring Season Expected. Some Materials Scarce.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, January 27, 1941.

The question of ocean freights is becoming increasingly difficult and rates are gradually advancing. While service from South America has heretofore been adequate, it is now very difficult to get space for fertilizers inbound on account of other better paying cargo. Our coastwise shipping is also being interfered with and quite a number of bottoms are being diverted to other services where the return to the operators is greater. All of these changes will undoubtedly have an effect on the price of such materials as move by water. The general tendency of freight is upward and will continue so long as the war lasts.

The Spring fertilizer season is in the offing and indications point toward a normal demand for mixed goods with little, if any change in prices from last season.

Sulphate of ammonia is scarce and in good demand. Nitrate of soda, an adequate supply for current season already on hand. Active demand in prospect.

Fish scrap and meal exceedingly scarce as result of very poor fishing season. Spring fishing will not start before March, so the trade is turning to tankage in lieu of fish.

Potashes are still available at the list but most resales carrying discounts have disappeared.

There is a fair export inquiry for certain basic ingredients but volume has fallen off. This, however, is likely to be a temporary situation as America will inevitably be the principal source of supply with Europe eliminated for the present.

BALTIMORE

Little Change in Market. Manufacturers Have Ample Stocks on Hand. Sharp Rise in Burlap Bag Prices.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, January 28, 1941.

There have been no outstanding changes in the market on fertilizer materials during the past two weeks. The season on mixed goods will probably not open up for another month or six weeks, and in the meantime, manufacturers have ample stocks on hand. There is, therefore, not much activity anticipated in the interim.

Ammoniates.—The market on tankage for feeding purposes is ruling somewhat higher, being in the neighborhood of $3.10 to $3.20 per unit of nitrogen. South American blood is also higher, and figures around $3.20 per unit of nitrogen, c.i.f. Atlantic ports.

Nitrogenous Material.—The market continues quiet, and the nominal market remains unchanged at $2.55 to $2.65 per unit of nitrogen, f.o.b. Baltimore.

Sulphate of Ammonia.—There is no change in the situation, although some of the manufacturers have not been able to secure their full supplies, in spite of the fact that steel mills are practically running to capacity. The export market continues strong, and ranges from $42.00 to $45.00 per ton, in double bags, f.a.s. Baltimore.

Nitrate of Soda.—There has been a pick-up in deliveries, and it is anticipated that some of the manufacturers will use nitrate in their mixtures to displace sulphate where the latter is unobtainable. The Chilean Champion Brand is still quoted at $29.40 per ton of 2,000 lb., export warehouse, with usual differential for 200 lb. bags and in bulk.

Fish Meal.—The market is fairly well

Manufacturers' Sales Agents for **DOMESTIC**

Sulphate of Ammonia

Ammonia Liquor :: Anhydrous Ammonia

HYDROCARBON PRODUCTS CO., INC.

500 Fifth Avenue, New York

NATURAL

Chilean

Nitrate of Soda

Old Style and Champion

Both Guaranteed

16% NITROGEN

Valuable not only as a source of nitrogen, but also to help maintain the supply of other plant food elements *naturally* blended with it.

WE'RE ON YO' RADIO!

Enjoy the Uncle Natchel program every Sunday afternoon on WSB, WRVA, WSM, WIS, WOLS, WPTF, WBT, KWKH, WJDX, WMC, WWL, WAGF, WDBO, WSFA, WJRD, WJBY, WFOR, WAML.

CHILEAN NITRATE Sales Corporation

120 BROADWAY, NEW YORK

RALEIGH, N. C. ATLANTA, GA. JACKSON, MISS.

MONTGOMERY, ALA. COLUMBIA, S. C.

SHREVEPORT, LA. LOS ANGELES, CALIF.

cleaned up, and such small lots of resale Japanese sardine meal as are obtainable are quoted at $59.00 to $60.00 per ton, f.o.b. Baltimore.

Superphosphate.—No change in this market, which continues firm at $8.00 per ton of 2,000 lb., for run-of-pile, basis 16 per cent, and $8.50 for flat 16 per cent, grade, both in bulk, f.o.b producers' works, Baltimore. There are no heavy stocks accumulating, and any heavy demand will probably have the effect of strengthening the market.

Bone Meal.—The market on both raw and steamed bone meal continues quiet and unchanged. 3 and 50 per cent steamed bone meal continues to be quoted at $32.00 to $34.00 per ton, f.o.b. Baltimore, with South American 4½ and 47 per cent raw bone meal ranging from $31.00 to $32.00 per ton, c.i.f. Baltimore.

Potash.—There has been practically no resale demand, and it now looks as though most of the manufacturers will be able to secure their normal requirements at the schedule. Such resale material as is obtainable is being firmly held at 55c per unit, in bulk.

Bags.—The market on burlap for early delivery is sharply higher, and plain, new, 10 oz. bags, basis 40 cut 54 in., for spring delivery are now around $131.50 per thousand, f.o.b. Baltimore, which represents an advance of about $13.50 per thousand during the past two weeks.

CHARLESTON

Organics Prices Higher. Some Chemical Materials in Short Supply. Fish Materials Scarce.

Exclusive Correspondence to "The American Fertilizer."

CHARLESTON, January 27, 1941.

Prices on all organics have advanced and are firm, but sulphate of ammonia and potash, as well as the liquid ammonia supplies are very short.

Nitrogenous.—Domestic can be obtained around $2.50 to $2.60 ($3.04 to $3.16 per unit N) delivered Southeastern ports.

Blood.—South American blood, in bags, has just been sold at $2.45 ($2.98 per unit N) c.i.f. Jacksonville.

Tankage.—Fertilizer grade around $3.00 ($3.64½ per unit N) and 10 cents, f.o.b. Chicago.

Sardine Meal.—No quotations on sardine meal and supplies of domestic menhaden remain exceedingly scarce.

Cottonseed Meal.—Around $31.00 for 8 per cent at Atlanta and $27.50 for 8 per cent at Memphis.

HIGRADE
MURIATE OF POTASH
62/63% K_2O
Also 50% K_2O Grade
●
MANURE SALTS
Approximately 30% K_2O
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SUNSHINE STATE POTASH
A PRODUCT OF NEW MEXICO U.S.A.

GEARED FOR SMOOTH RUNNING

TO meet this country's need for adequate domestic supplies of potash, men and equipment at the United States Potash Company's mine and refinery are geared to peak efficiency. Employees and management alike recognize the new responsibility which has been placed on our nation's potash industry now that foreign supplies of this vital element have been virtually cut off.

But need for production will never cause us to neglect the quality of Sunshine State Potash. In peak as well as normal times, technical specialists, backed by complete laboratory facilities, control every step in production. Today more fertilizer producers than ever before depend upon Sunshine State Potash for consistently uniform analysis and careful sizing which makes handling and blending easy.

UNITED STATES POTASH COMPANY, INC.
30 ROCKEFELLER PLAZA
NEW YORK, N. Y.

CHICAGO

Fertilizer Organics Prices Firm in Spite of Light Sales. Feed Demand Improves and Material Prices Increase.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, January 27, 1941.

While reported sales of organics were light, they were sufficient to enable sellers to maintain previous quotations or even ask higher prices. Demand, however, is below normal at this period, but fill-in orders are anticipated during the next two or three months.

Active feed demand has resulted in blood prices moving up sharply, with stocks well depleted. Digester tankage and meat scraps demand has been strong at $2.50 per ton advance. Material market strengthened accordingly.

Nominal prices are as follows: High grade ground fertilizer tankage, $2.25 to $2.50 ($2.73½ to $3.04 per unit N) and 10 cents; standard grades crushed feeding tankage, $3.10 to $3.15 ($3.77 to $3.83 per unit N) and 10 cents; blood, $3.00 to $3.15 (3.64½ to $3.83 per unit N); dry rendered tankage, 65 to 70 cents per unit protein, Chicago basis.

TENNESSEE PHOSPHATE

Rock Shipments for Direct Application Decline. AAA to Supply Ground Rock in Soil Program. Progress in Construction Work Reported.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., January 27, 1941.

A vacation during the last half of December, and the consequent difficulty of keeping up with the greater activities of the first of the year, have combined to prevent preparation of this letter for the last three issues, the longest period of absence during the forty years it has been contributed.

Shipments of ground phosphate rock for 1940, from data so far obtainable, show about ½ of one per cent over those of 1939. Both November and December shipments declined so considerably in comparison with the same months of 1939 that the more than 10 per cent increase existing at the end of October was practically wiped out.

Much of this falling off is attributed by some sellers of rock phosphate to the far wider extension of the AAA program providing grants of aid for the manufactured phosphates into Illinois and the other areas where most of the ground rock is used for direct application.

To what extent this is true is highly problematical, but the program has been vigorously waged by all the Department of Agriculture forces, as well as by sellers of the limestone necessary for successful use of the soluble phosphates. In addition, the U. S. taxpayers will pay for all the phosphates used and will even finance its purchase by grants of aid, so that the farmer does not have to put cash down on the barrel-head. It is easy to believe that many farmers who intended to purchase their usual rock phosphate, are accepting the other materials provided them without cost. Even with the many post offices and other public buildings being erected, we do not hear of any campaign by government officials to have public building construction *entirely* supersede normal private construction.

Although grants of aid have heretofore been provided only for the manufactured phosphates, it is now being arranged in eleven counties of Illinois to provide grants of aid for rock phosphate also, and it is said that bids will soon be asked for supplies of that product for AAA use. Through TVA supply, the treble superphosphate for such grants of aid is furnished in Illinois at $38.00 per ton and the 20 per cent superphosphate at $17.00 per ton, as compared with the ordinary Illinois commercial

PULVERIZED
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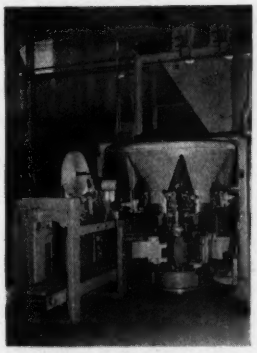
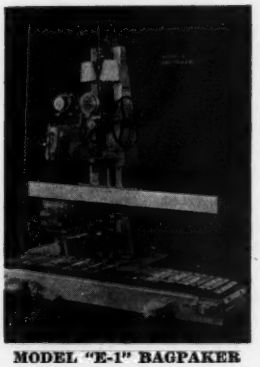
MAGNESIUM LIMESTONE
"It's a Dolomite"
American Limestone Company
Knoxville, Tenn.

IN CANADA

A Canadian Fertilizer Manufacturer recently installed a second Model "A" Bagpaker. This is a fully automatic machine that weighs, fills, closes and seals from 900 to 1000 one-hundred-pound bags per hour, with only one operator.



MODEL "A" BAGPAKER



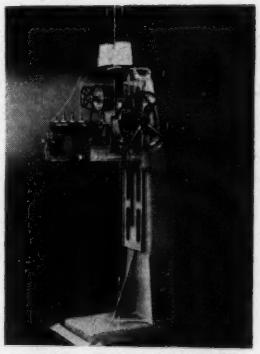
MODEL "E-1" BAGPAKER

IN THE MIDWEST

A Midwestern Fertilizer Manufacturer ordered two more Model "E-1" Bagpakers for shipment in January, bringing their total Bagpaker installations up to nine. This Model "E-1" Bagpaker is a semi-automatic machine that will close from 15 to 18 one-hundred-pound bags per minute, provided your equipment can fill and weigh at this speed.

IN OHIO

An Ohio Fertilizer Manufacturer, about to offer a new product to the trade this Spring in Bagpak Paper Bags, has purchased an "F-1" Type Bagpaker for immediate installation. This is a semi-automatic unit to be mounted over his present conveyor.



MODEL "F-1" BAGPAKER

* Trade Mark reg. U. S. Pat. Off.

Preparedness
TODAY'S KEYNOTE

Are you prepared this Spring for an increased demand for your product in Bagpak* Heavy Duty Multiwall Paper Bags?

Here is what some of our other customers are doing.

All Bagpaker Machines make the well-known Cushion Stitch form of closure. Each is equipped with a specially designed sewing machine which lays a thick, soft cord across the bag end and cross-stitches around it without going through it. This cord forms a cushion, or shock absorber, that takes up the strain of handling and prevents the stitching from pulling through the bag walls . . . the closure is actually the strongest part of the bag. The Model "A" Bagpaker illustrated above applies tape **over** the stitching with latex, completely sealing the package.

We make a series of Bagpaker Machines for every purpose and for every purse; also spouts and necessary packing room accessories. Bagpak Paper Bags are furnished with our All-Weather Kraft sheet at **no extra cost.** We are prepared to give your inquiry immediate attention.

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"ONE MAN PACKAGE . . . . . EASY TO HANDLE"

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prices of $48.00 and $24.00, respectively. The TVA, in their cost figures on treble superphosphate, estimates the cost of rock at $4.00 per ton. If this figure is used, it means the farmers of Illinois who join the AAA program will get rock phosphate at about $9.00 per ton, paid by the U. S. taxpayers.

About the only thing the sellers of ground rock, who have had such hard sledding for the past 40 years, can do is to keep on in the hope that the publicity being given to phosphate will make more customers, who cannot get it free from the AAA, but who will be willing to pay a legitimate figure for it.

Construction activities have progressed satisfactorily and the enormous new furnaces installed by Monsanto in the Century district and by Victor at Mt. Pleasant are reported as in splendid operation from the start. Considerable progress is being made by TVA in the development of pumping stations, washing and mining plants and in the large sintering plant previously reported.

The plant for making mixtures of rock phosphate, potash and sulphate of ammonia, which started operations in Columbia, has been closed down after shipping a number of cars. It is understood that the fertilizer regulations of Ohio, where most of the shipments went, prevented sale of such mixtures with guarantee of only the total phosphoric acid content, and under the A.O.A.C. definition of "available," not enough could be guaranteed from the rock phosphate in the mixture to meet the requirements.

The Middle Tennessee Technical Society has recently held two very interesting meetings. The discussions have included description of the Tennessee phosphate deposits from a geographical standpoint, the mining and milling operations with various processes for the recovery of different grades of material, the manufacture of triple superphosphates by the wet process for which two plants are in operation in this field, and notes on the production of ferro-alloys and especially ferro-manganese which is now being produced at the Rockdale plant of the Tennessee Products Co.

On January 24th, a Tennessee Fertilizer Conference was held at Nashville, a report of which appears elsewhere in this issue.

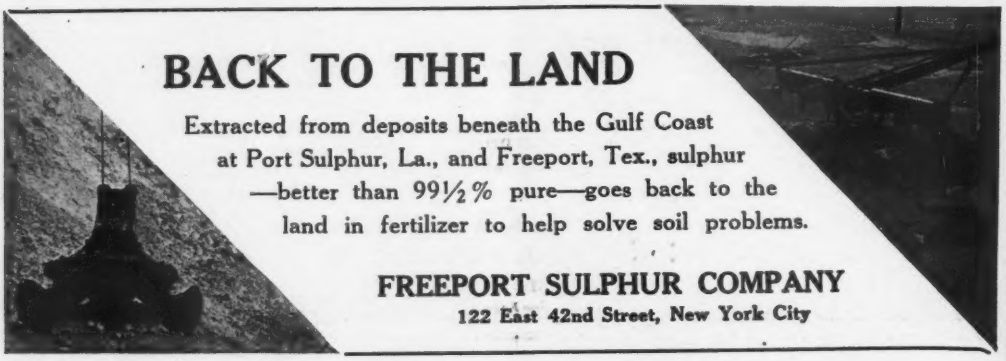
FERTILIZER PELLETS AND CUBES

(Continued from page 7)

reported for $\frac{3}{16}$ inch superphosphate pellets ranged from forty to fifty cents a ton. Where large size cubes or pellets are made, the cost per ton is less, for the capacity of the same mill with a die of larger holes is considerably greater. Thus, where a given mill with a $\frac{3}{16}$ inch die extruded 35 one-hundred pound bags of a given product per hour, the same mill with a one-half inch die produced 55 one-hundred pound bags of the same product.

Less costly granular material of small size can be produced by using dies with large holes and instead of cutting the pellets or cubes with standard cutting knives, by attaching what is known as kibbling knives. Subsequent to kibbling, the fertilizer is carried directly to shaker screens where the fines are removed and aspirated back to the tempering or conditioning chamber while the kibbled material is separated to the desired sizes and dropped to the cooler. It is believed from some limited study of the feeding of kibbled fertilizer in a fertilizer drill that the tendency for the material to run through the drill openings when the machine is not operating is slight, for the irregular surface tends to prevent the same free flow as is the case with very uniform pellets or granules.

In making pellets of manures or organic materials, there is a marked increase in weight per unit volume. In one operation of poultry manure pelleting, the dried pulverized manure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Agricultural authorities have shown that a lack of Boron in the soil can result in deficiency diseases which seriously impair the yield and quality of crops.

When Boron deficiencies are found, follow the recommendations of local County Agents or State Experiment Stations.

Information and references available on request.

AMERICAN POTASH & CHEMICAL CORPORATION
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Pioneer Producers of Muriate of Potash in America
See Page 4

weighed twenty-five pounds per bushel while the pellets made from this manure weighed fifty-nine pounds per bushel. There is much less difference in the weight per unit volume of pulverized inorganic fertilizers and in the pellets made from such fertilizers, though in the case of all fertilizer materials which the writer has pelleted there is some over-run.

Pelleting inorganic or organic fertilizers, or mixtures of these, opens a new field for the sale of small package goods, profitably. The pellets are clean and odorless. More of this type fertilizer is being made each year.

LINK-BELT SPEEDER ANNOUNCES CONVERTIBLE SHOVEL

A new, lightweight ¾-yd. convertible shovel-dragline-crane, Model 75, is announced by Link-Belt Speeder Corp., 301 W. Pershing Road, Chicago, as a companion to its popular LS-85 heavy-duty ¾-yd. machine.

All-welded steel construction has replaced castings in the new "75." The power plant is a heavy-duty gasoline or Diesel engine with smooth-running roller chain drive. Alloy steel, machine-cut spur gears drive the reverse and drum shafts. These turn in heavy bronze bearings.

External band clutches enable the operator to "feel" the load at all times. This sensitivity, plus external band brakes operated by automotive type pedals, is said to result in perfect control of the load and the greatest accuracy in placement. All brake bands are instantly accessible for adjustment and can be removed easily for re-lining.

A large-diameter turntable and long, wide crawlers give the Model "75" extra stability on slopes and in heavy digging. The turntable is made of alloy steel with internal gear. A roller path machined on a bevel permits the use of large, wide-faced conical rollers that revolve without slippage. Upper and lower frames are connected by a heavy alloy steel center quill with large adjusting nut.

A three-piece traction shaft driven by fully enclosed alloy steel bevel gears transmits full power to the crawlers by means of heavy, heat-treated roller chains.

Crawler shoes are abrasion-resisting, non-clogging, lug driven, with close pin centers to insure smooth action. Added stability results from using double-faced track rollers, increasing the effective crawler width. Track adjustment is provided at both ends to maintain perfect alignment and tension.

Controls operated from within the cab permit steering in both directions, either gradual or sharp, regardless of the relative position of cab and lower base. A positive traction lock, controlled from the cab and engaging in three positions, prevents movement of the crawlers while working, eliminating any necessity for chocks or blocking.

Working ranges, clearances and lifting capacities are given in a new folder sent upon request. Reader can get a copy by referring to Model "75" and addressing the manufacturer or his nearest distributor.

FARM INCOME IN DECEMBER

"Farm income in December apparently declined less than the usual seasonal amount," according to a report of the U. S. Department of Agriculture. "Marketings continued large, and there was a further increase in the index of prices received by farmers. Improvement in the domestic demand for farm products accompanying the recent substantial increases in industrial output and consumer income, together with the effect of national farm programs in stabilizing prices of basic farm commodities, has been sufficient to more than offset the effects of greatly reduced exports and has resulted in an increase in the general level of prices received by farmers.

"Exports of agricultural commodities continue on a restricted basis, the value having averaged less than 4 per cent as large as farm income from marketings during the 6 months ending last November, compared with over 11 per cent in the 6 months immediately preceding. It is possible that a shortage of shipping and the advantages of the short North Atlantic route to Europe, together with other developments, will eventually bring about a material increase in agricultural exports, but the near-term outlook is for little if any improvement in exports of domestic farm products."

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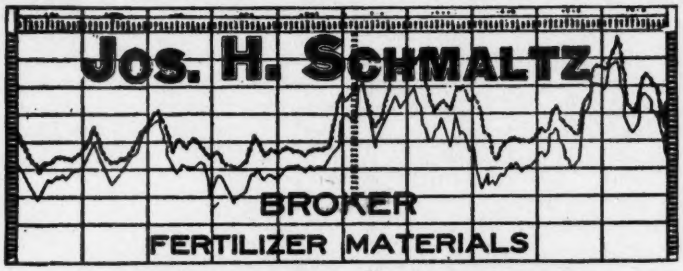

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RECENT EXPERIENCE WITH PHOSPHATE FERTILIZER

(Continued from page 11)

the ionization of the basic or acid constituents which are present in excess in the soil. When the difference between the basic and the acid content is comparatively low, ionization can proceed only at a comparatively low pH value. If, however, this difference is high, then ionization can proceed at a comparatively high pH value.

The cultivated fields of any farm, particularly the loamy ones, are characterized by a comparatively high difference between the basic and the acid content. Hence, in such a case, a comparatively high pH value is needed if the aluminum and iron are to be prevented from becoming ionized. However, a low pH value is very common, with the unfortunate result that the phosphate condition is unfavorable.

According to recent findings, "the phosphate condition is improved" by increasing the pH value. This can be done by adding phosphate, silicic acid and humus. The phosphate condition of the soil can also be improved by increasing the pH value (liming). However, the best results are probably obtained by employing all of the expedients already mentioned.

The excess of phosphate in a form which can be readily taken in by the plants can be furnished by applying phosphate in sufficient amounts. The soil is then, as the layman would say, "saturated" with respect to phosphoric acid. This, however, frequently requires such large amounts that it is not economically feasible to carry it out; that is, if it is a question of thus saturating the whole humus layer.

But is it really necessary to do this? It is known that a plant can "assign" certain roots to take in phosphate and other roots to take in the rest of its needed plant food. It would therefore seem that it is only necessary to saturate the soil to a suitable degree in those parts where the plant satisfies its requirement of phosphate, that is, in the root zone. Investigations on the growth of plant roots carried out by the Department of Agriculture do, in fact, indicate that such a solution to the problem is possible.

In this way, as a result of an extensive series of phosphate experiments, it becomes clear that granulated phosphate is superior to pulverized phosphate. The principle of placing the phosphate vertically in the field has, however, been developed still further in that the granulated phosphate is applied in holes drilled in the field, which operation can easily be done by means of a conventional drilling machine, having rigid shares, as found in American type drills. In this manner, therefore, we can provide in a field whose phosphate condition is unsatisfactory, strips of phosphate-rich soil right in the root zones. Accordingly, phosphoric acid is made available to plants physiologically and locally.*

In a type of soil which, to judge from its phosphate condition, would be the hardest one of all to do anything with, that is, a very acid clayey loam, there was obtained, in thus applying the granulated phosphate in holes, a yield of oats higher by more than 2,710 pounds per acre than when the same amount of phosphoric acid was supplied in the form of pulverized superphosphate and harrowed in as far down as possible.

* It seems the tests refer to the band method of application developed in the U. S. A. *Editor.*

(To be continued in the next issue)

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A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, Including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

ACID BRICK
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMO-PHOS
American Cyanamid Co., New York City.

AMMONIA—Anhydrous
Barrett Company, The, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA LIQUOR
Barrett Company, The, New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA OXIDATION UNITS
Chemical Construction Corp., New York City.

AMMONIATING EQUIPMENT
Sackett & Sons Co., The A. J., Baltimore, Md.

AUTOMATIC ELEVATOR TAKEUPS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BABBITT
Sackett & Sons Co., The A. J., Baltimore, Md.

BAGS AND BAGGING—Manufacturers
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Paper
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

BAGGING MACHINES—For Filling Sacks
Atlanta Utility Works, East Point, Ga.
Bagpak, Inc., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

BAG-CLOSING MACHINES
Bagpak, Inc., New York City.

BAG PILERS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City.
Armour Fertilizer Work, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City.
Armour Fertilizer Work, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City.
Pacific Coast Borax Co., New York City.

BROKERS
Ashcraft-Wilkinson Co., Atlanta, Ga.
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Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Keim, Samuel L., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

BUCKETS—Elevator
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
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Menhaden Fish Products
and
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A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CALCIUM-NITRATE
Synthetic Nitrogen Products Co., New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
Du Pont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

CASTINGS—Iron and Steel
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
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Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
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CHEMICALS—Continued
Huber & Company, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
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Chemical Construction Corp., New York City.
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Gascoyne & Co., Baltimore, Md.
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Jeffrey Manufacturing Co., The, Columbus, Ohio.
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Phosphate Mining Co., The, New York City

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Chemical Construction Corp., New York City.

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Tennessee Corporation, Atlanta, Ga.

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Huber & Company, New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
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Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
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BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

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Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DRYERS—Direct Heat
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

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Link-Belt Company, Philadelphia, Chicago.
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DUST COLLECTING SYSTEMS
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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio.
International Agricultural Corp., New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
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MACHINERY—Power Transmission
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Stedman's Foundry and Mach. Works, Aurora, Ind.

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MACHINERY—Tankage and Fish Scrap
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Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNETS
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
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MIXERS
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
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Wellmann, William E., Baltimore, Md.

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American Agricultural Chemical Co., New York City.
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Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
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Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

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Southern Phosphate Corp., Baltimore, Md.
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Wellmann, William E., Baltimore, Md.

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Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
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Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
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Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

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SEPARATORS—Air
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SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill. and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
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International Agricultural Corp., New York City.
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SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

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Baker & Bro., H. J., New York City.
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McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland Co., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

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Sackett & Sons Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

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Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
Du Pont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
Du Pont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
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